



STATE OF CALIFORNIA

DEPARTMENT of TRANSPORTATION

MATERIALS ENGINEERING AND TESTING SERVICES

OFFICE OF RIGID PAVEMENTS and STRUCTURAL CONCRETE

5900 Folsom Boulevard
Sacramento, California 95819



Interstate 5 – South Bound
KP 0.0 to KP 2.7

DOWEL BAR RETROFIT EVALUATION

DISTRICT 12
Orange County
Interstate 5

Contract Number: 12-093904

October 2001

ACKNOWLEDGEMENTS

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Peterson/Chase General Engineering

INDUSTRY

**Western States Chapter of the
American Concrete Pavement Association**

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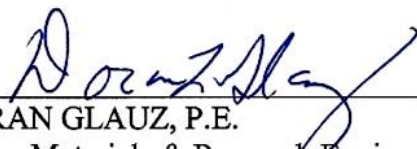
This report reflects the observations, findings, conclusions, and recommendations of the authors. The contents do not necessarily reflect the official views or policies of the State of California.


This report does not constitute a standard, specification, or regulation. The Office of Rigid Pavement and Structural Concrete is responsible for the accuracy of the information and data presented in this report.

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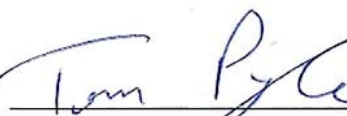

TOM PYLE, Chief
Office of Rigid Pavement
and Structural Concrete

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SUMMARY

A current dowel bar retrofit project in District 12 on Interstate 5 (I-5), near San Clemente in Orange County, is exhibiting signs that construction work is not conforming to the project plans and specifications. The project is between the El Camino Real Under crossing and the San Diego County Line. Recent counts show that this segment is subjected to an Annual Average Daily Traffic (AADT) from 115,000 to 145,000.

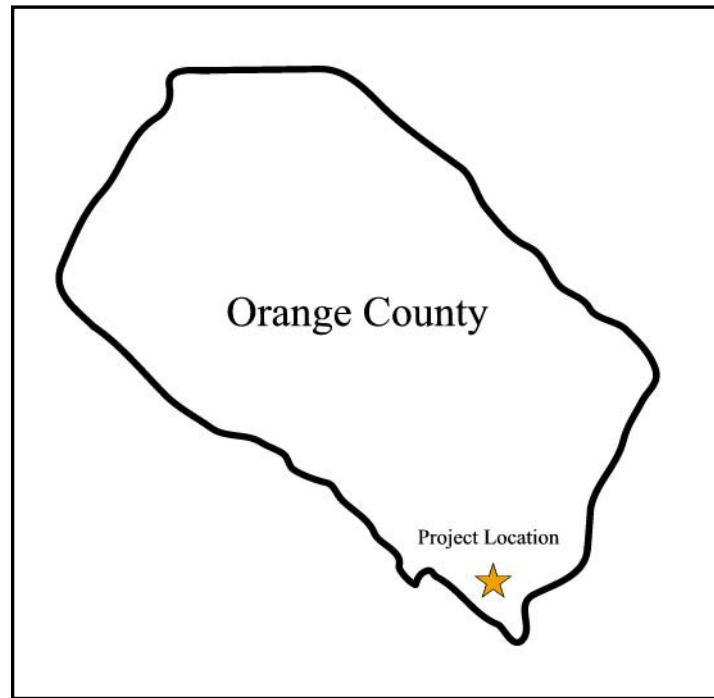


Figure 1. Project Location

District 12 Maintenance requested that the Office of Rigid Pavement and Structural Concrete evaluate the dowel bar installations and make recommendations.

An on-site visit was made on October 2, 2001 to assess the present status of the installations. Core samples were taken during the visit.

Data and information were obtained from the following sources:

- a. Project plans
- b. Verbal communication with District 12 staff
- c. Observations during the on-site visit.
- d. Examination of the core samples

The investigation focused primarily on the pavement distresses observed and the core samples.

Among the distresses observed were:

1. Backfill grout excess/overflow
2. Roughness and poor consolidation of grout at the surface
3. Dowel bar ends at the concrete surface of replacement slabs

PROJECT DESCRIPTION

This project is rehabilitating a 2.7-km long segment of I-5 primarily by retrofitting and grinding most of the existing panels and by replacing failed panels in both the northbound and southbound directions. The project limits extend from the San Diego County Line (station 0+00) to the El Camino Real Under crossing (station 27+10).

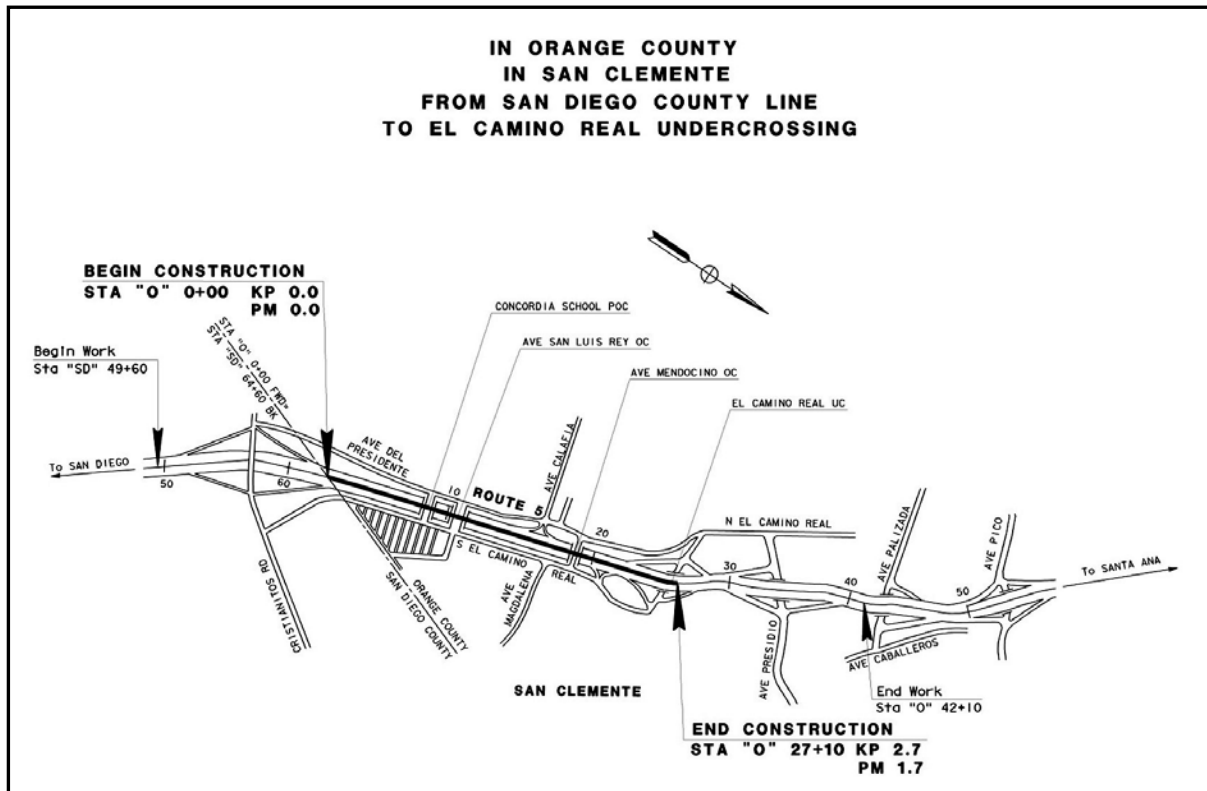


Figure 2. Project Limits

Construction Details

The rehabilitation project is currently ongoing. The limits for the dowel bar retrofit, grinding and slab replacement are from station 0+00 to station 27+10 in both the northbound and southbound directions (Figures 3a and 3b). Specific locations for the work performed can be found on the project plans.

The retrofit requires that dowel bars be installed in the transverse joints of the existing panels. Dowel bars are installed by saw-cutting slots parallel to the direction of traffic in the existing pavement. A dowel bar, with a foam board insert and chair supports, is placed in each slot. The slots are then backfilled with fast setting grout (Figure 4). The fast setting backfill grout is required to be finished 3 ± 1 mm above the existing pavement surface and ground smooth within 30 days after the slots are cut.

The dowel bars are specified to be 457-mm long, 38-mm diameter epoxy-coated smooth bars evenly spaced at 305-mm intervals, in the inner and outer wheel paths of the lane. The dowel

bars should be placed at a depth where the dowel centerline is at mid-depth of the pavement slabs. The project plans show the concrete pavement in lane 4 to have a depth of 275 mm.

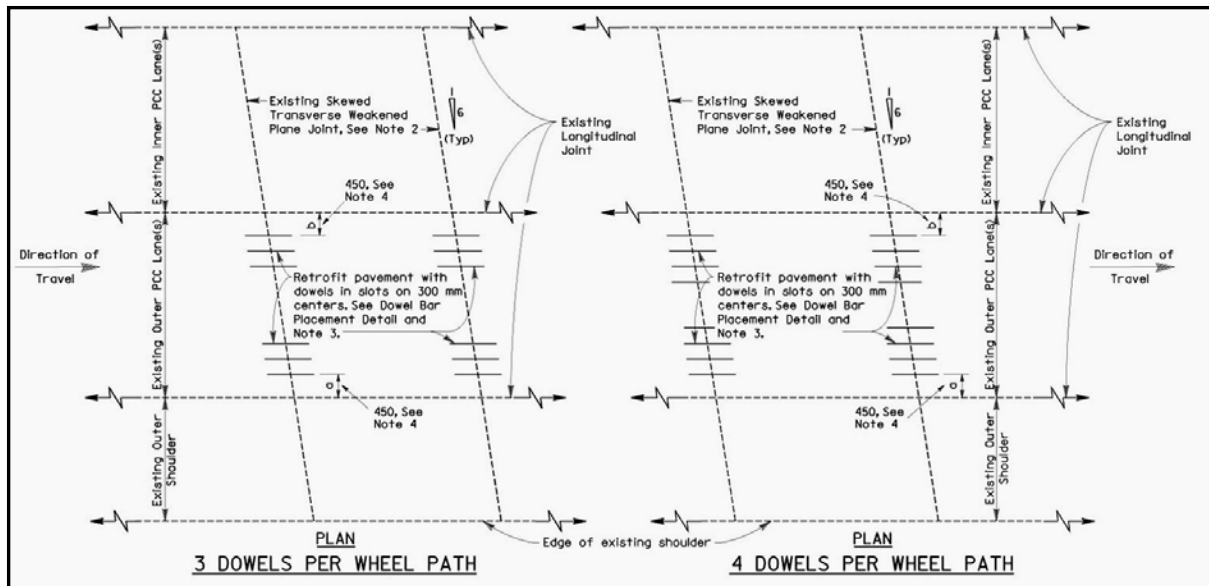


Figure 3a. Dowel Bar Retrofit Plan

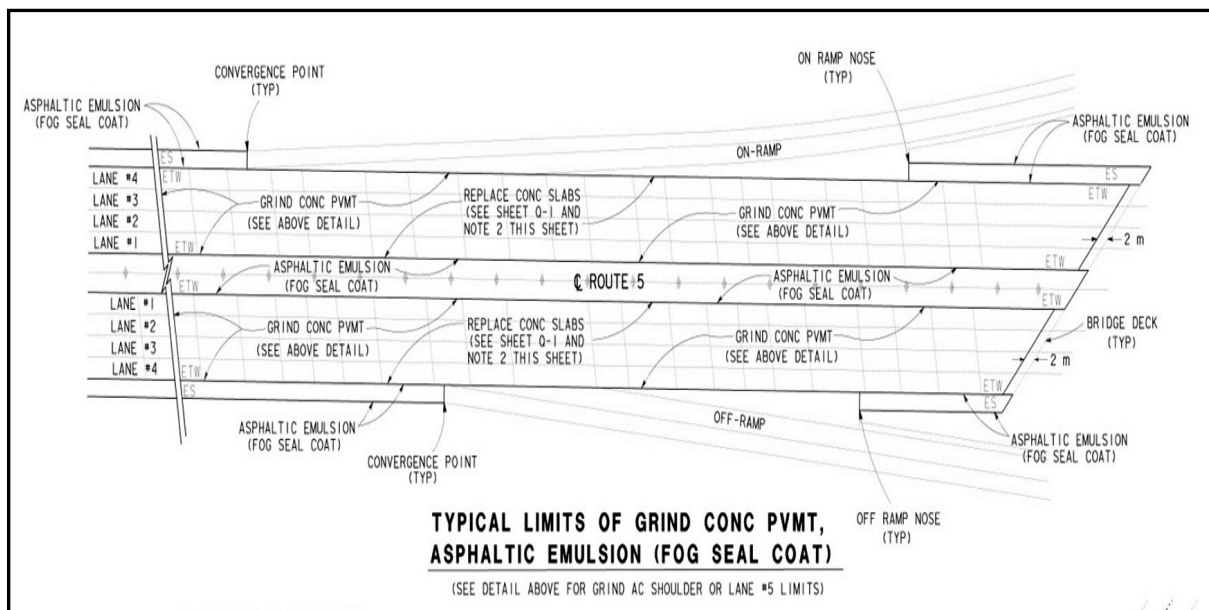


Figure 3b. Pavement Grinding and Slab Replacement Plan

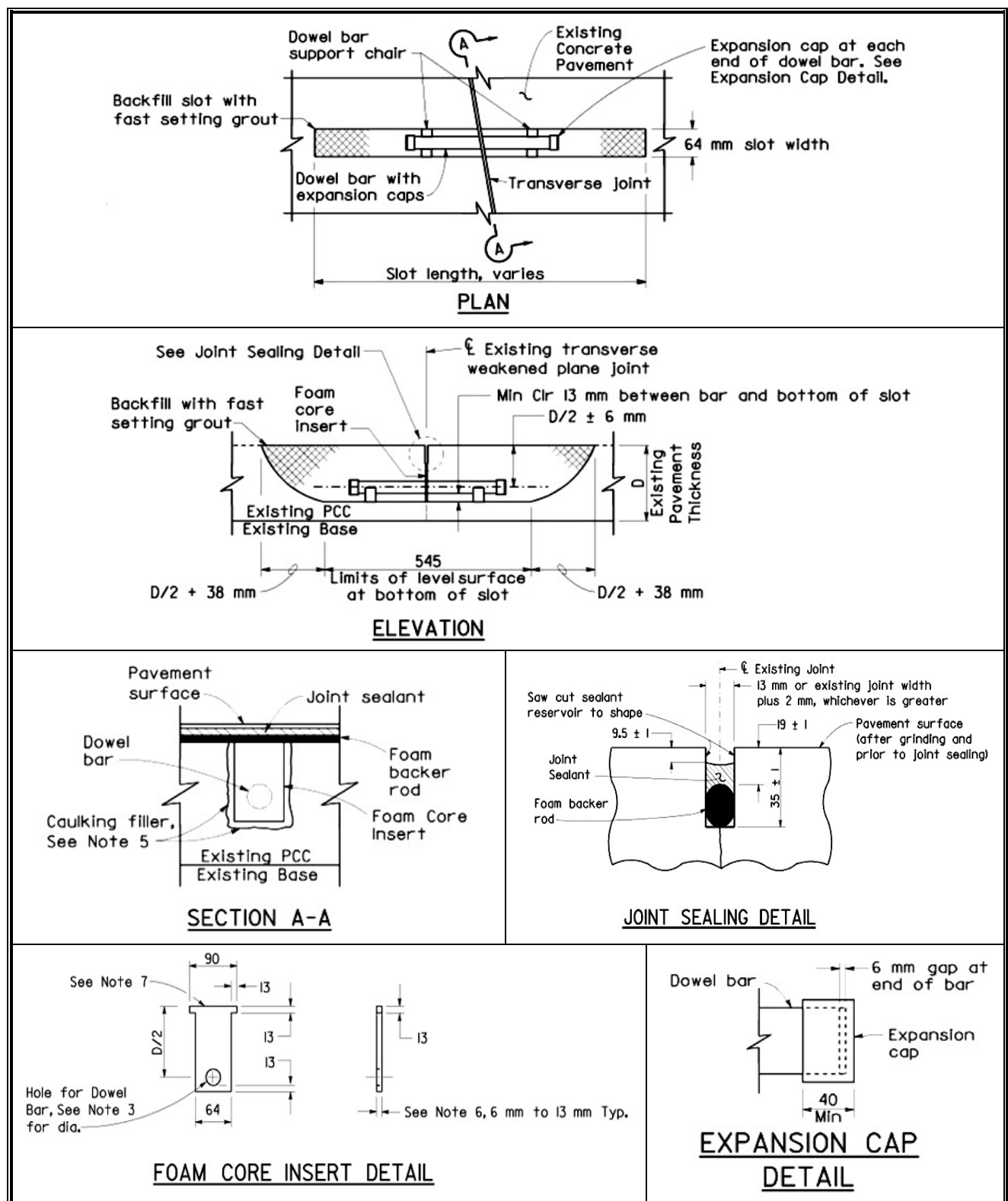


Figure 4. Dowel Bar Retrofit Details

INSPECTION TEAM

Pavement inspection was performed by:

Office of Rigid Pavement and Structural Concrete

Doran Glauz	Senior Materials & Research Engineer
Karl Smith	Maintenance Manager I
Raul Alarcon	Transportation Engineer

District 12 - Maintenance

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Contractor

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Industry

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OBSERVATIONS

Dowel Bar Retrofit

The pavement inspection was performed on Tuesday, October 2, 2001. Upon arriving at the project site, the ride over the dowel bar retrofit installations was found to be rough. Several panels along the retrofitted segment from the El Camino Real Under crossing to the Mendocino Over crossing in lane 4 were examined. Core samples were taken at various locations to evaluate the backfill grout and replacement concrete. The installations appeared messy due to the abundance/overflow of backfill grout in and around the slots. Traffic loading has begun to break off the excess grout. A total of 4 dowels per wheel path were installed at the transverse joints, as required.



Figure 5. Dowel Bar Retrofit Installation

The backfill grout in some of the slots observed was between 5 mm and 10 mm above the pavement surface. The project special provisions require that the fast setting backfill grout be finished 3 ± 1 mm above the existing pavement. Some slots had a rough finish, showing poor consolidation and other flaws at the surface (Figure 6).

Three cores were taken at retrofit slots. The cores showed that the top of the dowel bars were at 112, 113, and 109 mm below the surface. The top of the dowel bars should be at 118.5 ± 6 mm below the surface. The grout in the retrofit slots was fairly well consolidated and predominantly free of voids. In the second core sample, mentioned above, there was a significant void under the dowel bar chair supports indicating that the backfill grout failed to fill the slot entirely (Figure 7). In the third core the support chair was not resting on the bottom of the slot indicating that the dowel was either moved during back filling or not properly placed.

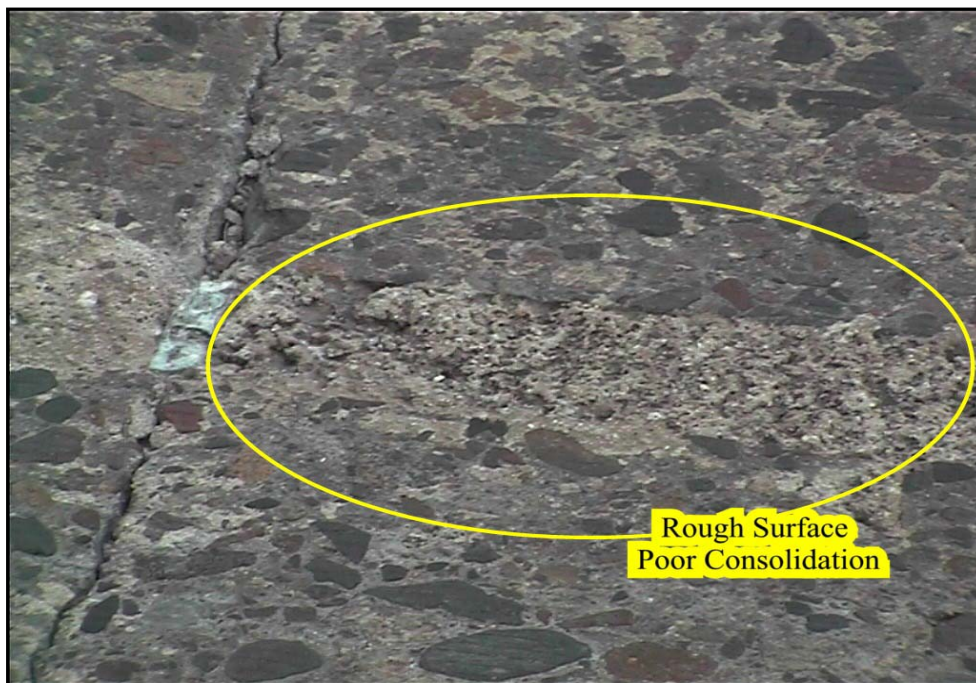


Figure 6. Backfill Grout



Figure 7. Void under Dowel Bar Support

Many of the foam boards were aligned with the existing transverse joint. The foam boards are approximately 12-mm thick and seem to be adequate for maintaining the existing joint. Occasionally, the foam board was pushed or folded over at the surface; this may indicate that the dowel is not at the correct depth.

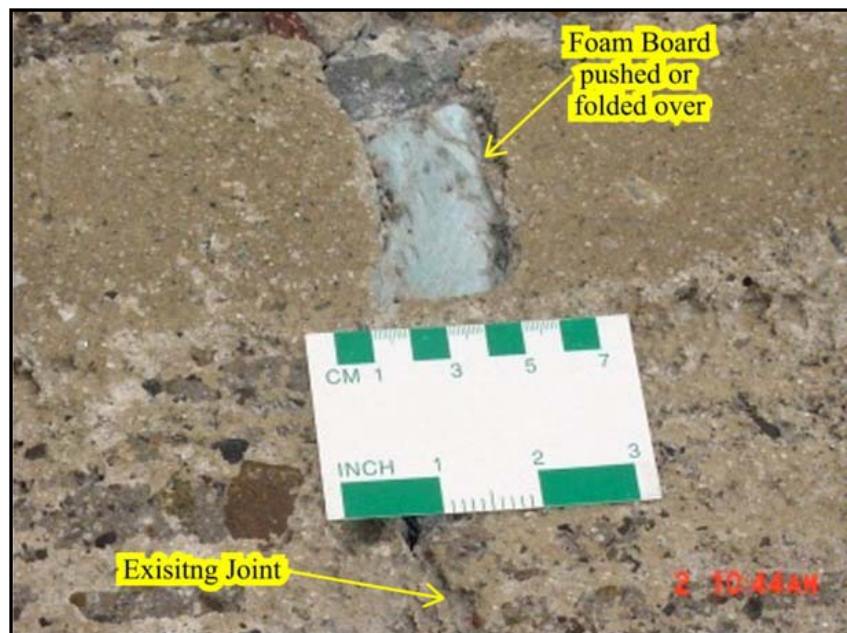
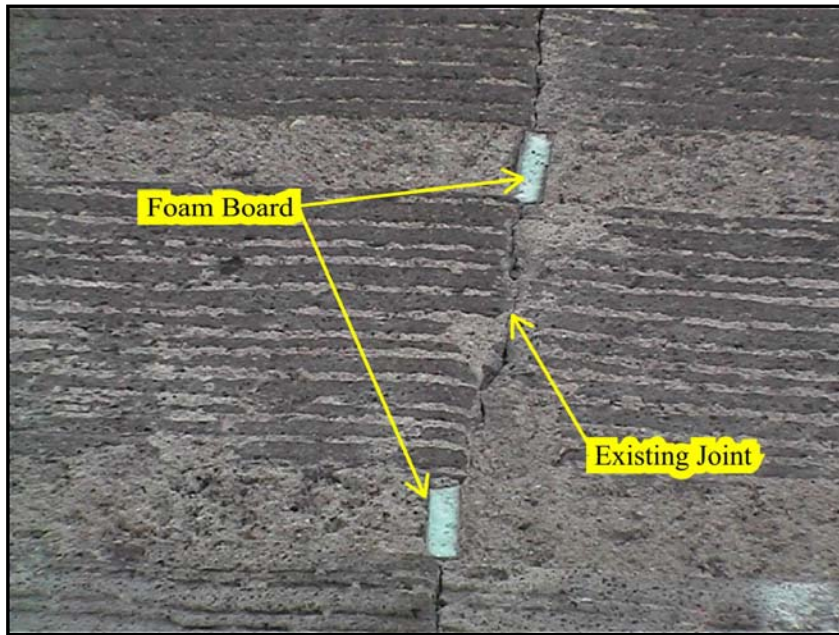


Figure 8. Foam Board Alignment

Slab Replacement

Slab replacements were also examined. The contractor installed dowel bars in the replaced slabs by using dowel bar assemblies (baskets). While inspecting the replaced slabs, a total of three dowel bar ends were discovered at the surface near the joints in two different slabs.

Two of the dowel bars were further examined by coring. At the first dowel bar, the embedded end was cored and found to be 140-mm below the pavement surface (Figures 9 and 10).



Figure 9. Dowel Bar A

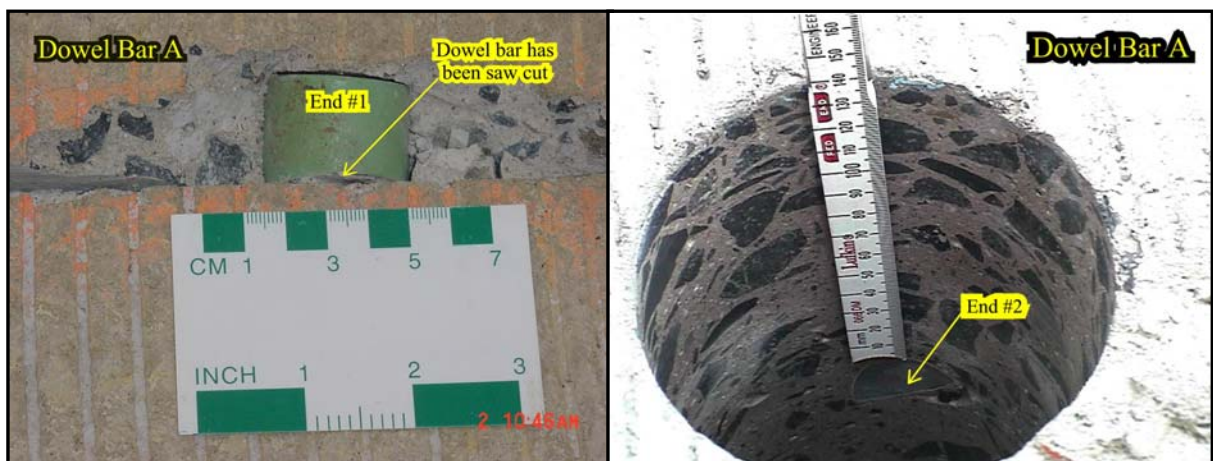


Figure 10. Ends of Dowel Bar A

At the second dowel bar, a 150-mm core was taken at the exposed end in an attempt to capture part of the dowel bar support assembly (Figure 11). The assembly was not captured.

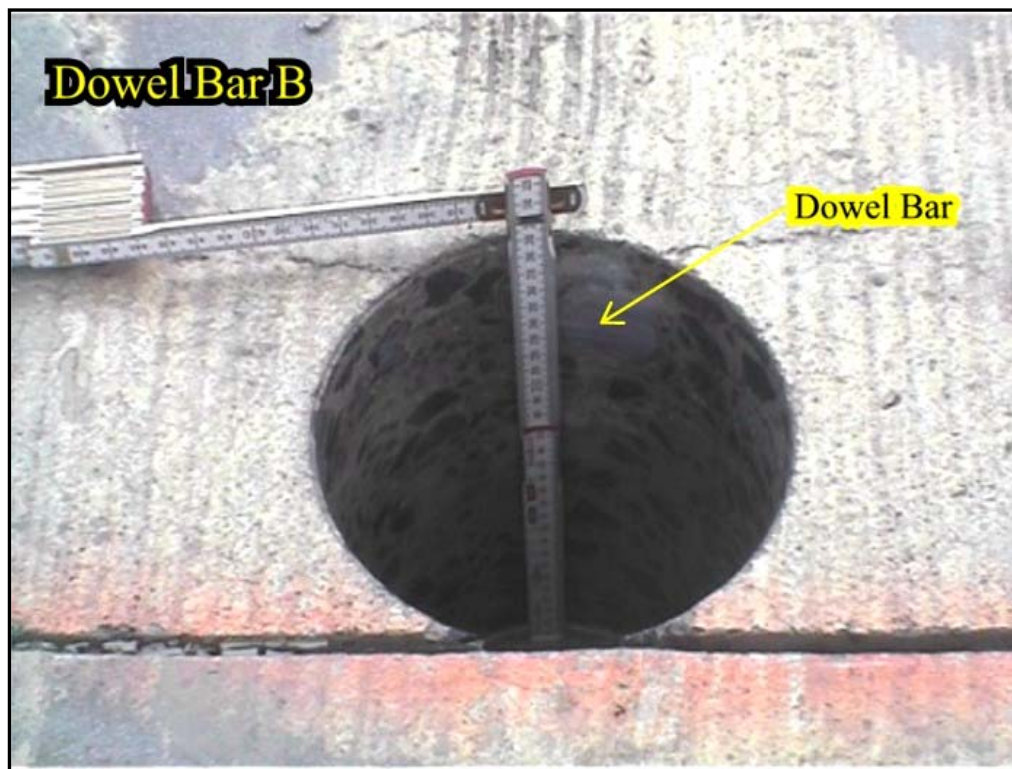


Figure 11. Dowel Bar B

FINDINGS

According to the assistant resident engineer, more than 30 days have passed since the dowel bar slots were cut and they have not been ground smooth as required.

The project's special provisions require that the engineer's representatives “attend a 4-hour training class on dowel placement techniques.” A request for Headquarters Construction to provide an instructor for this training was not made.

CONCLUSIONS

The intermittent rough finishes are evidence that at times the grout was ‘over-aged’ or allowed to stiffen before placing was complete. It appears that too many dowel bar slots are being backfilled from a single batch of the fast setting grout.

The dowel bars seem to be being disturbed during grout placement.

The alignment of the dowel bars and/or assemblies in the replaced slabs appear to have been displaced during the concrete placement operation. The resident engineer or inspectors should have information in their records as to how this may have occurred.

RECOMMENDATIONS

Construction work should be performed in accordance with the project plans and specifications.

Both the engineer and contractor’s representatives should attend the 4-hour training class on dowel placement techniques required by the project special provisions. Training material should be reviewed and approved by Headquarters Construction prior to the class.

“Fast setting grout shall be mixed in accordance with the manufacturer's instructions.” It is imperative that the contractor and inspectors be aware that the available working time of the fast setting grout is limited. Grout batches should be sized so that the entire batch can be used, placed, and consolidated within the allowable working time. Any material that cannot be placed and consolidated within that time should be discarded and properly disposed of.

“The grout shall be vibrated with a hand held vibrator capable of thoroughly consolidating the grout material into the slot and around the dowel bar support chairs.” If the grout cannot be placed and vibrated without disturbing the dowel, an external downward force should be applied to the dowel during that operation.

The surface of backfilled dowel bar slots should be rounded 3 ± 1 mm above the existing concrete surface as specified. Grout finishing that does not conform should be immediately rejected. Specifications for future projects should require that backfill material exceeding this

height should be reduced within 48 hours or administer a pay deduction per slot per day beyond this time period.

Dowel bar retrofit and finishing grout that does not conform to the Special provisions should be removed and replaced.

Dowel bar slots should be ground smooth within 30 days from the initial saw cutting.

The existing transverse joints were constructed by the insert method. Many of the joints show minor deterioration. The joint openings remain tight and have little or no build-up of incompressibles. These joints should not be saw cut and sealed. Widening the joint opening may increase the infiltration of incompressibles, water, and other deleterious material.

Pursuant to Section 6-1.04 of the Standard Specifications (1999), "DEFECTIVE MATERIALS," the Engineer should direct the Contractor to remove and replace the concrete pavement, and associated work, that does not conform to the requirements of the plans and specifications. Due to the lack in workmanship, it is necessary and appropriate to require that the Contractor determine the extent of non-compliant dowel bar assemblies by coring at each transverse joint. The Engineer should witness the coring operation and decide whether the dowel bar assembly complies with the requirements of the plans and specifications. The costs for all work required for identifying the extent of compliance or non-compliance; removal and replacement of non-compliant concrete pavement; and placing of backfill at cored locations of compliant concrete pavement should be borne by the Contractor.

POINTS OF CONTACT

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ADDENDUM

Dowel bar placement

Additional measurements were made on the dowel slot depth and bar position. The measured depth of the saw cut is equal to that called for in the plans. The support chairs for the dowels, in all cases, are not resting on the bottom of the saw cuts; however, they are not so far off the saw cuts as to lift the bars out of the specified depth range. The placement of the dowels in the cores is at or just above the high limit of the required range. The plans call for the height of the chairs in the slot to be 13 mm. The chair height in the core samples were found to be 17 to 19 mm from the base of the chair to the bottom of the bar. With the chair design placing the bar 4 to 6 mm above the required depth, the slightest misalignment can easily push the dowel beyond the specified tolerance.

Two other chairs, made by separate manufacturers, were measured and found to hold a dowel 16 mm above a horizontal surface. When inserted into a tight fitting slot a bar would be lifted slightly more.

There are two exclusive recommendations on the support chair height issue.

1. The chairs need to be redesigned to conform to the 13 mm specification
2. The depth of saw cut on the plans need to be redefined to meet the dimensional requirements of the support chair.

The second is the preferred because it enables maximum potential for innovation and competition, i.e. lower cost.

Doran Glauz
11/15/01

